



Material Handling Research Center (MHRC)

Georgia Institute of Technology and University of Arkansas

Improved tools and strategies to store, move, and control materials will reduce logistics costs

Center Mission and Rationale

The United States spends nearly a trillion dollars each year on the logistics of material flow. An increasingly complex global economy revolves around the movement of goods, including raw materials and subassemblies. The Material Handling Research Center (MHRC) is the only research organization in the United States devoted exclusively to the systems needed to facilitate and manage material flow. The material handling system extends from the last value-adding step at a supplier through the entire production process and distribution network until a product is received by the customer. Companies may also become responsible for the return or disposal of packaging material and/or shipping containers. Germany, for example, requires that manufacturers collect all packing material and return it to the manufacturing site for disposal. Other countries are considering similar measures.

The Center's mission is to improve domestic productivity by developing methodologies and tools to analyze, operate, and design material handling systems for industry and Government. The Center performs approximately \$3 million of research annually and serves about 30 companies. Forty faculty supervise some 70 students working on projects directed at the

needs of MHRC's members. The Center also acquires technology from other countries through technology exchange agreements.

Research Program

The research performed in the Center is divided into several program areas:

- **Manufacturing Systems.** This area focuses on the scheduling of production systems and the problems of material flow through the manufacturing process. Emphasis is on customer-centered, high-mix, flexible production systems. The research involves scheduling, planning, and control systems, in-plant material transport, modeling and simulation, and computer-aided design and operating tools. MHRC's accomplishments in this area include determining the size and location of buffers to maximize the throughput of flexible manufacturing system (FMS) installations, developing computer aids to design automatic guided vehicle (AGV) networks, and selecting and assigning components for insertion and onsertion machines.
- **Warehousing Systems.** This area focuses on the efficient utilization of cubic volume and the speed and accuracy of withdrawals and replenishment. The research involves service times for automated systems, advanced order-picking techniques,

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Visits to member company sites for benchmark studies also provide insight into practical day-to-day problems.

location/allocation of storage, inventory reduction, and computer-aided tools for facility design and operation. Past projects include development of software to determine which items should be stored in a given technology, assignment of storage locations to improve order-picking efficiency, application of conveyors to sortation, development of operating strategies for automatic storage and retrieval systems (AS/RS), and comparison of part-to-picker and picker-to-part systems. Future projects will integrate a number of these advances in an artificial intelligence-based design/analysis workstation for distribution centers and warehouses.

- **Logistics Systems.** This area focuses on the interplant and intraplant flow of material and the strategic location of manufacturing plants, depots, and distribution centers. Ongoing research includes topics such as route design, multichannel distribution networks, allocation of products and customers to manufacturing and distribution centers, facilities design, and conveyor network design. Research results include algorithms for laying out linehaul/backhaul routes, fixed delivery routes, and collection sites for recyclable material. Future projects will focus on a computer-based set of design and analysis tools for the interactive investigation of a wide range of tactical and strategic logistics issues.
- **Flexible Automation.** This area focuses on improving the utility or efficacy of existing hardware. Research topics include low-cost vision systems, autonomous AGVs, and robotic applications. MHRC's research resulted in the formation of a spin-off company to produce low-cost vision systems that determine the location and orientation of objects, navigation techniques for autonomous AGVs, and the feasibility of vision-based smart tags as an alternative to radio frequency smart tags.
- **Information Systems.** This area focuses on the information that must accompany material movements and the application of artificial intelligence to material handling problems. MHRC's research involves expanding the integrated computer-aided manufacturing definition (IDEF) approach to include the information flow as well as the material flow needed to support a manufacturing enterprise, as well as models to handle unscheduled events such as machine breakdowns or material shortages. Past research resulted in software to automatically palletize random-size packages, a system to automatically load and unload truck trailers, and an integrated production control system to fabricate optical fibers.

The Center is also performing research to determine the best way to size and manage



Sophisticated programs and advanced displays for modeling material handling systems

reusable containers in a closed-loop system, to promote standard-size containers and pallets, and to reduce injuries during manual material handling.

Special Center Activities

MHRC-developed technologies have resulted in a pattern of substantial cost savings for the Center's industrial sponsors. Selected accomplishments by the MHRC include —

- Assisting a major electronics manufacturing firm in redesigning its material acquisition operation, which resulted in a reduction of Work-in-Process (WIP) inventory by \$100 million while reducing staffing requirements by \$3 million annually.
- Developing quantitative design software that enabled a major military avionics firm to save \$400,000. The firm used the software to review an AS/RS acquisition designed by traditional methods. The software revealed that the equipment was significantly over-designed.
- Developing algorithms to allocate and slot electronic chips on automatic onsertion equipment, which resulted in productivity increases of more than \$1 million monthly for a major electronics manufacturer.

After attending discussions at MHRC, the U.S. Postal Service learned of reusable and recyclable alternatives to wood pallets and began using plastic pallets, which resulted in a savings of several million dollars annually.

MHRC also collaborates with other I/UCRCs as appropriate. For example, MHRC cooperated with the Web Handling Center at Oklahoma State University to apply a motion

sensor (a correlating camera developed as part of an AGV navigation package) to the edge motion of a continuous web. MHRC also collaborated with the Center for Plastics Recycling Research at Rutgers University, and the two Centers jointly designed a waste collection and recovery system for the State of New Jersey.

In addition to hosting visiting scientists from Asia and Europe, MHRC is negotiating a technology exchange agreement with the Fraunhofer Institute in Dortmund, Germany, a major European center for material handling research.

MHRC provides research opportunities to minority students from the two Center campuses, Tuskegee University, and Clark Atlanta University.

Center Headquarters

Center Director: Dr. H. Donald Ratliff
Georgia Institute of Technology
The Logistics Institute, School of
Industrial and Systems Engineering
765 Ferst Drive
Atlanta, GA 30332-0205
Phone: (404) 894-2307
Fax: (404) 894-0390
E-mail: hratliff@isye.gatech.edu

Center Evaluator: Dr. J. David Roessner
Public Policy
Georgia Institute of Technology
Atlanta, GA 30332-0345
Phone: (404) 894-6821
E-mail: david.roessner@pubpolicy.gatech.edu